DSN Telemetry System Tests

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The overall DSN System test plan, as edited for the DSN multi-mission Telemetry System, is briefly described. Specific results, with delivered Mariner Mars 1971 telemetry software, are presented in relation to this test plan. Recommendations are included for future system demonstration, specifically as to system documentation and training.

I. Introduction

As stated in the DSN Standard Test Plan, the purpose of the DSN system tests is to verify that DSN capabilities meet multi-mission design/operational standards and that systems can be transferred to DSN Operations. Particular DSN telemetry system tests and their objectives are shown in Table 1. With the arrival of *Mariner* Mars 1971 DSIF/SFOF software and GCF's HS/WB system, the DSN inaugurated its system test activity.

Since both the DSIF and SFOF telemetry software were being delivered in phases or models, DSN telemetry test procedures were written for scheduled delivered capabilities, progressing toward a completed system in support of *Mariner* Mars 1971 orbital operations.

II. Test Activity

During December 1970 and January 1971, DSN system tests to verify interfaces and data flow were conducted with SFOF, GCF, and CTA 21 elements of the DSN Telemetry System. Throughput of 8⅓- and 33⅓-bps engineering data was attempted. Serious problems were encountered, namely, the inability to process complemented telemetry data, abnormal number of missing data blocks, and the high failure rate of the 360/75 computers. Testing was further hampered by lack of any user guide information, lack of available telemetry formats, and the competition for computer time between system test activity and facility development. During the latter phases of these tests, DSSs were scheduled for support with mixed results. In summary, 8⅓- and 33⅓-bps simulated spacecraft engineering data were processed through the DSS telemetry system.

Early in March 1971, with delivery of the SFOF model 2 and the DSIF phase 2 software, DSN multimission and performance testing began. Building upon previous DSN tests, the telemetry system demonstrated processing of simulated spacecraft 8⅓- and 33⅓-bps engineering data for output and display on TTY, line printer, and digital TV devices. Telemetry system standard processors, i.e., engineering unit conversion, alarm limits, and data range suppression, were exercised.

In the beginning of the test activity, the 360/75 computer experienced excessive backlogging of the engineering data being output to display devices. Also, data backlogging was observed when large background processes, other than the operational telemetry program, were concurrently operating in the same 360/75 computer. Telemetry data recall from the DSIF's original digital data record and from the SFOF's digital system data record was accomplished. However, if the 360/75 computer should fail, there is no file protection for the system data record. On April 23, 1971 this test activity culminated in a four-station, four-spacecraft stream combination telemetry system test without noting any serious data backlogging.

A third round of DSN telemetry system testing began with the delivery of the SFOF model 4 and the DSIF phase 4 software in late August 1971. Simulated spacecraft 50-bps science and 8⅓- and 33⅓-bps engineering data were throughput to the DSN telemetry system. No failures of the SFOF 360/75 processor occurred as a result of data backlogging. One- and two-kbps science data were also received from the DSIF by the 360/75 and logged. The DSN Telemetry Analysis Group assisted in isolating simulation problems with the new DSIF simulation conversion assemblies. Another new telemetry feature, the automatic data stream selection routine, was found to function properly. This allows the selection of the best telemetry stream for comprehensive processing and display, from two separate DSSs tracking the same spacecraft. Background sequential operation of the user analysis program along with the operational telemetry program in the same 360/75 caused no interference. The *Mariner* Mars 1971 Project Mission and Test Computer confirmed medium (1–2 kbps) and high (8–16 kbps) rate data flow through the system. Demonstration of data recall from the system data record and better control of the DSN telemetry system elements due to better visibility with added new television formats was witnessed by the DSN Telemetry Analysis Group.

III. Conclusion

These tests have confirmed the basic soundness of the DSN test plan and ensuing procedures. Complete multimission test objectives of the test plan will have to wait until the delivery of the DSIF and SFOF *Pioneer F* software to operate in the same DSN telemetry processors. These tests are scheduled for December 1971. In retrospect, it is hoped that the facilities schedule will allow adequate test time to be better prepared for the system level tests that follow. Operator training was also deficient due to the stringent test schedule and competition for resources. It would help considerably if even the preliminary facility documentation was available for system testing. DSN system transfer agreements between development and operational interests were executed for *Mariner* Mars 1971 launch support capabilities. Presently, transfer agreements are being pursued for *Mariner* Mars 1971 delivered orbital capabilities.

Table 1. Telemetry system tests

Test and objectives	Description	Prerequisites	Standards	Resources	Participants
1. DSN system test: Verifies interfaces, data flow.	Repetitive frames of S/C data are generated by SIMCEN, routed via an HSD to a DSS, where SCA and MM test set transform them to RF signals. These are acquired, demodulated, data is extracted and formatted and transmitted via HSD to the SFOF. Data is decommutated, routed and displayed by the 360/75 to the telemetry analysis area where the tests are conducted and results are analyzed.	Applicable facility systems have been tested and transferred to operations.	820-2 Latest edition Section III.	1 DSS: TCD, receiver/exciter, simulation conversion assembly, multimission test set GCF: 1 HSD, 1 TTY, 1 VOICE SFOF: 360/75, Telemetry Analysis Area SIMCEN SOFTWARE: TCD/MMT S/W, SCA S/W, MMT S/W, TCD/MMT diagnostics, MDR/EDR S/W, General Purpose Commutation, Simulation Center S/W for 2 S/C with up to 4 subcarriers.	Test Supervisor: DSN S.E. Test Conductor: DSN Ops Chiefs. Test Associate: Contemporary P.E. DSIF Facility Engineer. SFOF Facility Engineer. DSN Telemetry Analysis Supervisor. Telemetry Analysis Group and supporting facility personnel.
2. DSN system multiple-mission test: Verifies system integrity, multiple-mission capability.	Following additions to test 1: Generation of configuration and standard and limits messages by the telemetry analysis group relayed to and executed by the facilities. Periodic generation of TM system status messages relayed to Ops control. Demonstration of generation within 24 h of telemetry system data record.	Completion of DSN system test (telemetry).	820-2 Latest edition Section IIB.	Same as above.	Same as above.
3. DSN system performance test: Measures system parameters (bit rates, subcarrier frequencies) and modes of operation.	Following additions to test 2: With SIMCEN exercising telemetry system, bit rates are varied and telemetry modes are demonstrated. Tracking and command systems are operated simultaneously. This test is conducted under conditions simulating a typical planetary mission profile. Sharing of processors with the other DSN systems, on a non-interference basis, is demonstrated. This includes real-time changes to the telemetry system.	Completion of multiple-mission tests of telemetry and command systems and completion of all tracking system tests.	820-2 Latest edition Sections IID and IV.	Same as above plus command plus tracking resources.	Same as above plus command plus tracking test participants.